Simulation of Holographic Imaging based on Magneto-Optical Spatial Light Modulator

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1. Introduction

Electronic holography imaging based on a magneto-optical (MO) spatial light modulator (SLM) is a promising technique for realizing three-dimensional (3D) TV displays. Novel fabrication facilities have recently made it possible to create MO-SLM devices driven by spin transfer switching, referred to as the spin-SLM technology [1]. For effective functionality of those devices (depending on both MO and micromagnetic properties), optimized materials and dimensions of the display elements (developed layers and patterned pixels) must be chosen, which requires extensive simulations prior to fabrication. For this reason we present simulations of holographic reconstruction images created by coherent illumination of an MO-SLM-based display at various geometric configurations (angles and distances of image observations) and compare them with simulations of the direct observation of the 3D object and simulations of an image reconstructed from experimentally recorded holographic pattern.

2. Local modes method

All simulations are carried out by an original Matlab program created for this purpose. As the modeling technique we use the local modes method (LMM) based on the scalar diffraction theory, which treats each point of the patterned display structure as a laterally homogeneous multilayer with the well known Jones reflection matrices. The full image response is then calculated by Fourier-optics propagation technique in the Fraunhofer-diffraction approximation. The modeling procedures also use the Whittaker-Shannon sampling theorem with the sampling chosen according to the diffraction limit.

The simulation images are produced as follows: First, a virtual light object is created. The light then propagates according to Fourier-optics technique (using the expansion to plane waves) onto the detection plane, where the light intensity is recorded (simulation of a CCD camera). Then the recorded image is used to simulate polar-oriented magnetic ordering of the pixels of the MO-SLM. Such magnetically ordered display is then illuminated by a monochromatic plane wave to create diffraction waves, whose amplitudes are determined via the LMM. These waves are then focused by a reconstruction lens of an appropriate focal length, located at a chosen position. Finally the reconstructed image is detected in the image plane of the lens.

3. The effect of pattern edges

In the case of MO diffraction on magnetic patterned structures, it has been demonstrated that the diffraction of the edges of patterned elements within the display pixels might cause large optical effects, so that the LMM becomes insufficient [2]. For this reason we also simulate the accurate diffraction of the patterned elements with help of the rigorous coupled wave analysis (RCWA), which we use to improve the numerical precision of the LMM. Finally we discuss how the diffraction by the edge of patterned elements contribute in the observed images.

Acknowledgments

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[1] K. Aoshima et al., J. Display Technol. (2014) DOI: 10.1109/JDT.2014.2341243.
[2] R. Antos et al., Opt. Express **13**, 4651 (2005).

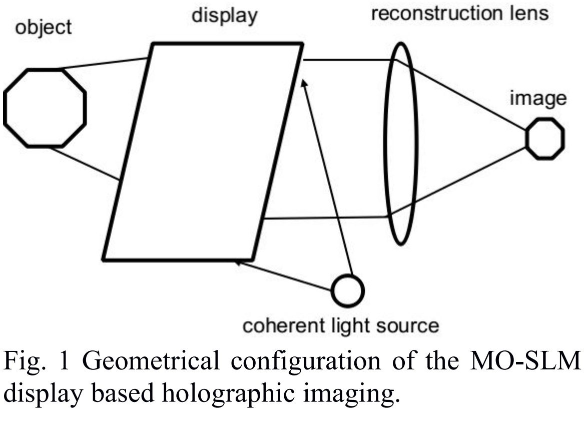

Fig. 1 Geometrical configuration of the MO-SLM display based holographic imaging.